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DR. FRANKLIN P. MALL: AN APPRECIATION

THE death of Doctor Mall is so recent and my grief for his loss so fresh that I find myself reflecting on the fruitful and delightful memories of our past association instead of writing out my impressions of his unusual personality.

Doctor Mall came to Johns Hopkins in the late summer of 1893 and just before the medical school opened its doors to the first class of students in the autumn. It was there that we met. I recall vividly my excitement and nervousness when the rumor was circulated about the old pathological building that Mall had arrived. His name had been a tradition among the small group in the department of pathology. A few years earlier, before the hospital had been opened to patients, he had come to the laboratory and as fellow in pathology had performed a miracle of interesting and important studies on the connective tissue foundations of the organs. Fellows in pathology there had been since his time, but no one whose memory was glorified as Mall's had been. We had so often heard him and his work spoken of by Doctor Welch, Doctor Halsted, and others, including the indispensable Schultz, who was for many years presiding genius over the technical and janitorial services of the laboratories and whose commendation carried with us such great weight, that I pictured Mall as quite different from what in actual life he proved to be.

One's fancy—my fancy surely was so—when young is apt to produce its own pictures. In my fanciful portrait of Mall I represented him as large, absorbed, and

rather austere. Never was a fancy more completely and happily shattered. I can just remember our meeting; those who knew Mall well will never forget how engagingly he smiled. It was with one of the best of his smiles that he greeted me.

That event was the auspicious beginning of a warm friendship which never wavered until his death. During the first period of half a dozen years we were in almost daily contact. Later, and after 1900, when I left the medical school to enter the University of Pennsylvania, our meetings were at first not infrequent. I shall never cease to regret the increasing intervals between them which followed my removal to the Rockefeller Institute in New York. Increasing responsibilities and enlarging duties play havoc with one's life, and I feel that I suffered a grievous and now irremediable loss in permitting those circumstances to cut me off to the extent it seemed inevitable they should from association with Mall. To a certain extent, letters took the place of personal contact. Thus I kept more or less in touch with the workings of his restless and constructive mind.

It probably will strike few except his very intimate friends that Mall was by temperament a reformer. He was an uncompromising democrat and hence entertained the firmest belief in liberty in its true and proper sense. Out of this intensity of conviction arose the views expressed in conversation more frequently but not more forcibly than in his addresses, on full opportunity and freedom in university education, both in its pre-graduate and post-graduate aspects. His comprehending and incisive mind was the first, I believe, to appreciate and afterwards to propound that the best of medical educational institutions were half-hearted affairs. That part of the institutions which a quarter of a century earlier had been the weakest—the laboratory branches namely—had been immeasurably strengthened in that short period, during which the previously stronger part—namely the clinical branches—had progressed relatively little. The balance could be struck and must be, even though in the process the old system were, if need be, completely shattered, as much shattered indeed as had been the earlier hybrid combined laboratory and clinical chairs. Out of this conception which Mall propounded, I am almost inclined to say preached to us persistently, arose the present movement, ever gaining force and strength until it has now become almost irresistible in favor of full-time clinical professorships.

It is very interesting to consider just here the extent to which he used others, converts or disciples as they may be called, to diffuse more broadly his reforming ideas. One would search Mall's miscellaneous papers, of which indeed there are notably few, in vain for an exhaustive presentation of the case for the full-time clinical plan. The wide dissemination of the idea by the printed page was left to others, while he maintained the high level of conviction in those coming under his immediate influence by an irresistible fund of logical exposition.

In his delightful essay on his master, Wilhelm His, Mall reveals his attitude toward higher education in its various complex aspects. I wonder how many returned foreign students have kept up an intimate correspondence with a revered teacher extending over a long period of time, like that disclosed by Mall in this essay. The extracts from his letters there published show how well the older man comprehended the younger, as the spirit and substance of the essay shows how the younger man admired and appreciated

the older. There is no doubt that His perceived in Mall rare personal and mental qualities, as he confides to him not only the subjects and trend of work, but his larger aspiration in the wide domain of anatomical research. In the light of the relation there revealed one can surmise the satisfaction and joy with which His, had he lived, would have welcomed the establishment of the Institute of Embryology with Mall as the first director.

In my task of presenting a fragment of the personality of Mall as apparent to his intimate friends and associates, I find myself embarrassed by the many memories that crowd my mind. It is not easy to select episodes. I love myself to think of the period during which he lived, as did the medical officers, in the Johns Hopkins Hospital, for then we were almost constantly together. The small, older group of men—older, that is, than the internes—saw much of one another. Mall, Frank Smith, Thayer, Barker, and I met always at dinner, frequently at breakfast and luncheon, at the small table at the head of the room. There was lively conversation and much variety of theme; and not a little good cheer. A small photographic print still exists which pictures the group; it is chiefly notable for the good likeness of Mall which it presents, showing him as it does in one of his happiest moods.

Mall returned to Baltimore as the first professor of anatomy of the new medical school. The physical conditions surrounding the launching of the medical school were so simple as to be almost austere. Aside from the hospital—a model of completeness at the time—the plan for housing the new departments of the school we should now regard as meager in the extreme. I sometimes think that it may be well to recall from time to time the simple beginnings out of which the great institution of the Johns Hopkins Medical School arose. The only additions made to the hospital buildings to accommodate the departments of anatomy, physiology, and physiological chemistry and pharmacology, were two stories added to the original small pathological building erected as a mortuary for the hospital and already housing the entire pathological department. It was in the upper, or fourth story, of that enlarged building that the complex department of anatomy took origin.

Some one else, who traces the growth of anatomy at the medical school, can tell better than I can how Mall adapted the limited space and facilities at his command to the teaching of anatomy, histology, and embryology, and to the conduct of research. There was no actual break in the continuity of his own investigations, and very soon after the medical classes were taken in he began to produce the new work which in a steady and increasing stream has come out of the anatomical department.

There were not a few obstacles to be overcome in getting the students' work properly started. I recall the shifts he was obliged to make to bridge over the gaps in dissecting until human cadavers became available. This period was for Mall, in many ways, an anxious one. But it was not long before this particular obstacle was overcome, and because of the improvements which he introduced in the preservation of human cadavers, his laboratory soon became the custodian of all the anatomical material employed for dissection and surgical instruction throughout the city.

The kind of teaching which Mall gave to his students has been described; there was no lecturing in his curriculum. He had almost a horror of lectures in anatomy; the idea collided with his fundamental

conception of how such a practical subject is to be acquired. In his views there was one road only to that goal. The student must teach himself in order to learn. Hence there were provided the objects to be dissected, text-books, atlases, models, and time, with a sufficiency but no excess of instructors or guides. He saw no virtue in exhibiting and describing a predissected part, provided the students were given opportunity to dissect for themselves. That this principle is sound no one will, I think, now deny. That its operation has produced a remarkably large number of superior, independent, and broad anatomists, the history of his department amply shows.

But a confusion of method and man is often made with disastrous consequences. It is easy to imagine this mode of teaching anatomy adopted widely without yielding the results which Mall obtained. To put the method into effect would doubtless represent a great advance over the old system, but without a strong, able teacher and guide, such as Mall was, the phenomenal results which he achieved would not be attained. In other words, he was a sound innovator because he was a strong man. He was a successful leader in anatomy because he was learned and original. He has left a rich heritage to science through his own labors and those of his pupils, because to all his other qualities he added the rare ones of wisdom, kindness and generosity.

Our proximity in the pathological building brought us into frequent association. In the early days of the medical school, Mall often attended the autopsies, many of which I performed. His active interest in the pathological phenomena continued throughout his life, in part possibly as the result of the year spent as fellow in pathology under Doctor Welch. But in fact he did not disassociate, as is often erroneously done, facts of pathology from those of anatomy. Being naturally inquisitive in regard to the relation of cause and effect in respect to the unit forms of organs, he was also prone to inquire into the effects of causes in their nature pathological.

At about the period when Mall was studying the lobular unit of the liver I was induced to attempt the application of some of the methods he worked out to cirrhosis of that organ—a mere illustration of the way in which two related departments through him were made to react on each other.

I imagine that few who knew Mall even quite well realize with what intensity of absorption and application he would work at a problem once he had gripped it, as one might say. In temperament he was naturally reflective. Hence there occurred periods during which he appeared to be doing little in his laboratory. At such times he would become possessed with the impulse to roam about the building or out into the city or into the adjacent country. It was remarkable that when under the influence of those moods he did not seek solitude so much as another form of activity. I was not infrequently taken away by him for a stroll through East Baltimore, and on these expeditions I acquired quite a knowledge of that part of the city. They were in many ways extremely interesting occasions, for during them he often talked his best and sketched advanced ideas on educational and other reforms, as well as on problems of research. I think Mall never dreamt idly. He was possessed of a romantic imagination, but it was both controlled and constructive. To not a few who did not understand him well his ideas sometimes sounded extreme, but they invariably rested on real foundations,

as is now evident since so many of them have been carried into practical affairs.

At other times he worked out problems in his laboratory with consuming intensity. It would seem as if while under what I have called the spell of his reflective mood, a problem would formulate itself more definitely, or some barring obstacle give way to a revealed point of view. However that may be, my notion was that the periods of reflection were signs that he would attack a new or solve an old problem; and I always looked for new ideas and accomplishments when the mood changed.

If I have at all succeeded in revealing Doctor Mall as he appeared to me, then I have presented to you a complex personality. The remarkable thing is the way in which all the pronounced qualities that characterized him were fused into a simple, harmonious, kind and lovable individuality. I have referred already to Mall's democratic spirit. He was an intense lover and active exponent of liberty. His belief and confidence in freedom extended far beyond the confines of the university and laboratory, and into the world of politics and government. Freedom within the university he held as the first condition of the successful struggle of the forces of light over superstition and darkness. Within the walls of his laboratory the fullest liberty prevailed. Once outside the realm of the prescribed task for training, each man followed the bent of his own talents and tastes. However, his principles as well as his practise sharply differentiated between liberty and license; hence the rise under him of a group of strong, independent, but sound teachers and investigators. Mall would probably have combated the suggestion that he produced a school of anatomists, using the term in its usual significance. He would probably have insisted that he merely continued in America the system which he pursued or saw in force in Switzerland and Germany. But I believe rather that he made such definite contributions to the higher education and training of anatomists, and produced in, alas! a few brief years so large a number of varied and capable teachers and investigators, as to mark a new era in the history of higher educational endeavor.

I said that his deep convictions of freedom carried him into the wider domain of social liberty. Mall never propagandized on this subject. He however felt intensely about it. It is noteworthy that with all the admiration for the freedom of migration from university to university and the wide election of subjects and ideas in the German university, to the social and political conditions of that country he was antipathetic. To so strong a "democrat," to use that term in its wider and better significance, a studied paternalism and imperialistic tendency were deeply unsympathetic.

Mall's sincerity, self-effacement, and never-failing consideration were at the root of his noble qualities and made companionship with him a rare privilege. I have already spoken of my own good fortune in possessing in some degree his intimate friendship. It is a rare possession indeed and one to be cherished. But I owe him also an educational impress, none the less valuable because of its subtle nature. I am of the opinion that his pupils were influenced by this unusual quality which because of its elusiveness seems an emanation—so little was it given off or received with immediate conscious perception.

Mall was absorbed in ideas. They formed the substance of his serious talk, but he was by no means a stranger to the lighter side of human relations, for he possessed a gentle and engaging humor

which might even, when provoked, become a little biting. It took time and some skill to penetrate an outer film of reserve which arose from innate modesty and shyness, but once beneath that protective covering, one readily discovered in him a simple, idealistic and gifted person of many sides, possessed of an almost miraculous power to stimulate students to put forth their best efforts. His memory and example will long survive in the achievements of his students and associates, in the broad ideas which he disseminated, and in the admiration and affection which he inspired.

Simon Flexner

The Rockefeller Institute
for Medical Research

FRANKLIN PAINE MALL: A REVIEW OF HIS SCIENTIFIC ACHIEVEMENT[1]

To those who are familiar with the history of medicine in this country, it is a matter of common knowledge that at the time Dr. Mall began his career, thirty years ago, anatomy in America had no scientific standing—a mere tool of surgery with but a single method, that of dissection. He left it where it must be in any community where medicine is progressive, one of its greatest sciences. He left it richly endowed with technical methods, a science so truly fundamental that workers in every other branch of medicine are constantly and increasingly returning to it, both for methods and for results. The vision of this change must have been his while he was yet a student for he wrote in one of his letters:

> My aim is to make scientific medicine a life work. If opportunities present, *I will.* This has been my plan ever since I left America and not until of late (since having received encouragement) have I expressed myself. I shall no doubt meet many stumbling blocks, but they are anticipated.

Sweeping aside the traditions of the dissecting room, he first created conditions under which this change could develop, and then devoted himself to scientific achievement and to the type of teaching in which he was profoundly interested. It was one of his oft-repeated maxims that the best and perhaps the only great way to teach is by example. With the ideal of scientific work as his goal, he has left us an example so rich in ideas, so varied in technical methods and so representative of the range of anatomy and embryology, that a study of his work is both an inspiration and an education.

His first undertaking in the field of research serves well to illustrate his independence of thought which, to those who knew him, was most striking. During the winter of 1885 he began his scientific work under His at Leipzig, who gave to him a problem connected with the gill-arches in the chick. In this study he came to the conclusion, now generally held, that the thymus arises from the endoderm of the pharynx, notwithstanding the fact that His held the view that it came from ectoderm. This work was given to His as Dr. Mall was leaving for Baltimore and was accepted for publication. In the next number of the journal of which His was editor, there appeared a second communication from the latter, strengthening his own point of view, but announcing that a different opinion would be published by one of his pupils in the next number. When Dr. Mall's article appeared, it was with a damaging footnote by His, to the effect that the independent character of the results was obvious. Two years later His restudied the region in a human embryo and found that Dr. Mall's conclusions were correct. He gave due acknowledgment of this in an open letter to

[1] Address given at a meeting in memory of Franklin Paine Mall held at the Johns Hopkins University, February 3, 1918.

Dr. Mall in the same journal, in which he states frankly, "Sie haben gegen mich Recht." This letter cemented a lifelong friendship, as can be readily seen from correspondence accompanying Dr. Mall's article on "An Estimate of the Work of His."

During the winter of 1885, His suggested that Dr. Mall work under the great physiologist, Ludwig. As Ludwig's laboratory was always full, the opportunity was slow in coming; indeed, as Dr. Mall wrote home, he was leaving Leipzig with no hope; his trunk was even on the way to the station when the letter came that the opportunity he so much desired was his. So great was the influence of Ludwig over his mind, character and future work, that it is impossible to overestimate it. He himself summed it up in these words: "To that master I owe much—all." Ludwig assigned to him the study of the villus of the intestine. His first impression of his new problem, as gathered from one of his letters home, was that here was a subject which had occupied the minds of the greatest anatomists of the past century. Repeatedly throughout Dr. Mall's writings there is to be found that expression of regard for the work of great minds. Widely read in his own subject, it was of the works which have lived that he made a profound study.

In Ludwig's laboratory Dr. Mall learned the methods of injecting blood-vessels and lymphatics, and his studies on the vascular system of the intestine and stomach are familiar to every student of medicine. Under the influence of Ludwig, his work was characterized by a very strong physiological bent. Indeed it may be said that his work was physiology in the hands of one with an intense interest in structure.

In some of the foreign universities it was the custom for a new incumbent of a chair to deliver an address giving, as it were, a "prophecy" or a "program" of his future work. Such a program was the famous address of His on accepting a chair in the Swiss University of Basel. In some such way the article of Dr. Mall on the stomach, published in the first volume of the Johns Hopkins Hospital Report, gives his program of the way he proposed to study anatomy. This paper lays a foundation for what may be called physiological anatomy. He studied the stomach from every aspect and with a wide range of methods. Here is the beginning of his brilliant work on the fibers of the connective tissues; here the studies on the normal contraction-wave of smooth muscle and the experiments on the reversal of those waves. In his paper on the stomach is this brief note:

> Recently I have found that irritation of the splanchnic nerve causes contraction of the mesenteric vein.

He probably first made this observation in Ludwig's laboratory and subsequently proved that the portal vein is supplied with vasomotor nerves, a valuable discovery in physiology.

The most important idea of this early work from the standpoint of anatomy is that of structural units, which Dr. Mall conceived from the study of the villus. The theory reaches its best expression in Dr. Mall's articles on the liver and spleen. It is that organs are made of ultimate histological units, represented in the vascular system by the capillary bed which intervenes between a terminal artery and its corresponding vein. Thus the size of the unit is determined by the length of the capillary. These units are grouped together into lobules. They are not only of great structural significance, since an organ is to be considered as a multiplication of them, but they are also of significance to physiology since such units are equal in

function. This equality of size and function comes from the laws of growth; when a unit increases in size so that the length of its capillaries increases beyond the norm, a new artery develops, the single unit splitting into two.

In his study on the spleen Dr. Mall brings out best the relation of all the tissues of an organ to its function. Thus he showed by experiments that the vessels of the spleen are emptied by the contraction of the bands of muscle on the trabeculae and that the fibers of these same trabeculae are so arranged as to distend the veins and compress the arteries as the muscles contract.

One of his valuable contributions is the study of the structure of the heart. He grasped the significance of the work of Krehl, which he said bore the stamp of Ludwig. In this work it is to be seen that the atrio-ventricular rings are tendons of origin for the bands of heart-muscle. In 1900 he gave the study of the bands of heart-muscle to John Bruce MacCallum, who unraveled the ventricles of the heart in the embryo pig into superficial and deep spiral bands with their origin and insertion in two tendons, the atrio-ventricular rings and the chordae tendineae. As a tribute to this brilliant work, Dr. Mall completed the study on the adult human heart after MacCallum's death, reducing the problem to the following simple terms: To understand the beat of the heart one must figure out how a muscular bag is constructed so as to empty itself. We have Dr. Mall's specimens in the laboratory showing how the spiral bands contract with each beat of the heart in the exact familiar pattern of wringing out a rag.

Another line of work which interested him greatly was the study of the brain. Here he was drawn to the anthropological side. Dr. Hrdlicka, the anthropologist in Washington, had said to him that the brain of a negro could be distinguished from that of a white man and with this in mind Dr. Mall made a comparative study of the brains in the anatomical collection, comparing them by weights, the complexity of their convolutions and other criteria. Realizing that no man can free himself of prejudice, he charted all of his data by means of numbers, filling in the race and sex only after the charts were complete. In this way he showed that the crude, present-day methods are inadequate for scientific deductions regarding the relation of the brain to race and sex. Of the criteria on race, there remains only the difference in the shape of the brain corresponding to the well-known shape of the head.

In his anatomical studies Dr. Mall has enriched his science with a wide range of methods. Our laboratory is full of examples of beautiful injections, corrosions of blood vessels, preparations of connective tissue made by maceration, cleared embryos to show the development of the skeleton and many others. His own methods of work in the laboratory are of great interest and he frequently discussed the influence of Ludwig in this connection. Contrary to the usual type, Dr. Mall was far more active mentally than physically. I have known him to think and plan with the greatest care so that a bit of routine might be simplified. Thus it was his habit to think out every detail of an experiment before he undertook it; he never employed the system of trying a thing out without adequate preparation or of approximating his methods through errors. For this reason he made but one experiment a day. If it failed, he would not repeat it until the next day, thus giving himself ample time to think out the reasons of his failure.

He was intolerant of the collection of unanalyzed material. His interest in technical procedures was only in their bearing

upon solving problems; it lay in understanding principles rather than in multiplying evidence.

We have outlined Dr. Mall's work in anatomy as it grew out of his study in Ludwig's laboratory. But he was not only an anatomist, he was also an embryologist. In 1891 he published an account of a normal human embryo, now placed in the fourth week of development. He made a most careful and accurate study of all of its systems, illustrated by the surface form, by models and casts. This was the first human embryo ever modeled in America and at that time it was the most complete account of any human embryo in existence. In this study he announced several discoveries, for example, that the Eustachian tube and the middle ear arise from the first branchial arch. The effect of this work on Dr. Mall is to be seen in these words in one of his publications:

> I always think in human anatomy in relation to this embryo.

Dr. Huber has said that this study has served as a model for all future work of its type. It did more for, like his work on the stomach, it represents as it were, Dr. Mall's program in embryology. This specimen forms the foundation of the priceless collection of over two thousand human embryos which Dr. Mall later gave the department of embryology of the Carnegie Institution of Washington. It was perfect, beautifully fixed and sectioned. When he had finished the description of it he offered it as a tribute to his teacher, His. His returned it, with several others of his own, expressing the wish that they might be the nucleus for a much larger collection. How richly has this gift borne fruit in the development of the science of embryology!

In the study of embryonic development, three names stand out in logical sequence, von Baer, His, Mall. Neither His nor Dr. Mall were concerned with the phenomena of maturation, fertilization or the cleavage stages, in the development of the embryo, but the latter has characterized the work of His as laying a foundation for histogenesis. In like manner the work of Dr. Mall in normal embryology may be summed up in the term organogenesis. He has traced the growth of organs up to their adult stage. He has laid the foundation for a complete anatomical survey of the human embryo in all stages of its development. Here, for example, belong his studies on diaphragm and the ventral abdominal walls and more strikingly his studies on the development of the loops of the intestine. These he followed from their beginning up to their position in the adult, he then determined their normal position in the adult by studies in the dissecting room, and by experiments on animals he showed that both the intestine and the omentum seek their normal position when disturbed. Of this work His wrote:

> Your satisfaction in your work will be lasting, because you have brought light into a field which was so obscure. The thing which has been lacking in all of our studies on development up to this time has been observations on the transition between the early embryonic and fetal stages up to the form of the adult. For the intestine you have given the entire study from the beginning up to the end, and I regard it a great step in advance.

It is in connection with the development of the vascular system that Dr. Mall made some of his most significant contributions to embryology. One of the most important points in the study of the embryo just mentioned was solving the problem of the primitive ventral branches of the aorta. This he did by showing that the vessels which are the forerunners of the celiac axis arise as far forward as the first dorsal segment and by indicating the method by which they shift back to their position in the adult. This work has since been repeated

with more specimens, but not analyzed with more insight. I recall in connection with these more elaborate subsequent studies on this subject, one of Dr. Mall's characteristic comments: "I can never become interested in the mere collection of new examples after a principle has once been thoroughly established." In connection with the study of the development of the vascular system the two lines of thought embodied in Dr. Mall's earlier work converge. These two generalizations I understand to be, first, that he approached anatomy from the standpoint of how structure is adapted to function, a different idea from that of the study of pure morphology, and secondly, that he saw the value of organogenesis to the study of anatomy. He carried over to embryology the methods of injecting blood-vessels and lymphatics in use for the adult and thereby made possible a complete account of the spread of vessels in the embryo. In the study of the vascular system he emphasized again and again the value of the study of an organ as a whole. Trained by the man who invented the microtome and himself making many improvements on it, he reacted strongly against those anatomists who study only sections. He was interested in the architecture of an organ; to use one of his own phrases he had "a feeling for structure." Indeed, he has often said that if he were to choose a career again, it would be that of an architect. His gift in anatomy, like the gift of the sculptor or the architect, was the power to visualize structure in three dimensions. Thus, one can understand his pleasure in the studies of the architecture of the vessels of organs, given not in indefinite terms, but showing the exact pattern of all vessels, the number and the relations of the orders of arteries from the main to the terminal branches. Thus he has left us a rich heritage of corrosions of the vessels of various organs which is worthy of a place in the great scientific museums of the world.

During the later years of his life, Dr. Mall became more and more interested in the problems associated with his collection; that is to say, in the type of problems for which institutes for research are founded, those that depend upon that analysis of large amounts of material and the cooperation of experts along closely allied lines. These problems touch more and more closely clinical medicine and social welfare. Such, for example, is the study of abnormal embryos, leading up to the analysis of their frequency and causes, the normal curve of growth, the determination of the age of the embryo and the causes of sterility and abortion. He first became interested in the study of abnormal embryos through separating the normal from the abnormal in his collection. His first general account of abnormal embryos was in the volume of the Johns Hopkins Hospital Reports published in honor of Dr. Welch in 1900. Eight years later he published a monograph on monsters, of which Morgan wrote:

> The recent publication by Mall on the causes underlying the origin of human monsters marks an epoch in the study of teratology in this country, for he has treated the subject with a breadth of view and a wealth of illustration rarely found in the handling of this complex question. Mall has brought to the task a profound knowledge of the older literature of the subject, an appreciation of the most modern results in experimental teratology, and a thorough familiarity at first hand with the subject of human monsters. The physician and anatomist are brought into close touch with work generally supposed to be outside their proper field; and on the other hand, the student of malformations in the lower animals will be made to appreciate the inexhaustible supply of human materials with which the anatomist and physician are familiar.

In this study and during the last six years, Dr. Mall has given a masterly analysis of the causes of monsters. He has shown

that from the earliest ages of the world's history the study of monsters has been one of the capital problems of anatomy, medicine and natural history; that the belief in supernatural causes gave way to the theory of maternal impressions, and that this must now give way to a scientific analysis of their causes. Dr. Mall recognized that a few abnormalities, polydactyly, for example, are germinal and can not be produced experimentally; but that monsters are not due to germinal or hereditary causes, but are produced from normal embryos by influences which are to be sought in their environment. The cause of monsters, he has indicated, lies buried in the non-committal term of faulty implantation. In his recent paper on cyclopia he has fully analyzed the meaning of recent experimental embryology. He showed that as soon as Stockard succeeded in experimenting with eggs in such a way as to produce cyclopian monsters at will, the explanation of the process was at hand, for the work demonstrated that a slight change in chemical environment, acting at a critical time, caused cyclopia. Dr. Mall studied the cyclopian monsters in his collection, one of which is at a stage where a complete analysis could be made, and in conclusion he says:

> It seems to me that the studies based upon our collection of embryos, as well as recent investigations in experimental embryology, set at rest for all time the question of the causation of monsters. It has been my aim to demonstrate that the embryos found in pathological human ova and those obtained experimentally in animals are not analogous or similar, but identical. A double monster or a cyclopian fish is identical with the same condition in human beings. In all cases monsters are produced by external causes acting upon the ovum.

Thus, most localized abnormalities and monsters, of which he gives a wealth of illustrations, can be traced back to the faulty nutrition of the embryo at early critical stages, and the effects can be followed with every grade of intensity, from complete degeneration of the ovum to monsters which survive to term. One of his most interesting deductions is that in some forms of faulty implantation there results a dissociation of the tissues of the embryo, so that they grow exactly as do the cells in the experiments with tissue cultures, without the correlating forces which check and integrate the organs in normal development. It is to my mind a significant example that this work has been carried on during the years given to the organization of a new institute, that is to say that Dr. Mall so planned the work of administration that it did not check research. It is not too much to say that this work of Dr. Mall's opens up a new field, and that it has already formed a broad foundation on which all future study of abnormalities must rest. Such was the work with which he was engaged at the time of his death. In his vision of an institute for embryological research, he saw that the two great lines of work in which he was most interested could be brought to a successful conclusion within a reasonable limit of time. First, that the full development of the study of organogenesis could give us a completely rationalized anatomy; second, that there is a group of problems such as the determination of the curve of growth, the study of abnormalities and their causes, normal and abnormal implantation which may perhaps be brought together under the heading of the study of the laws of growth, which lie beyond the powers of a single individual and thus must be attacked through organized research. Often he said during the latter months of his life: "My work is mapped out for the next ten years." Fortunately in his "Plea for an institute of human embryology" and in some unpublished manuscripts some of these plans are

recorded; but for the loss of those coming years that would have given us his greatest achievements, those achievements for which his whole life has been the preparation, no philosophy can console us. About a month before his death he put the question to me: "What would you say had been the effect of the Carnegie Institute of Embryology upon this laboratory?" to which I replied: "It has lifted the research of the place from a somewhat amateurish to a more professional state." Never shall I forget the pleasure in his face as he replied: "It is exactly what I wished to do." Such was his aim, such the ideal from which he had never swerved from the very beginning of his career.

No account of Dr. Mall's scientific work is complete without a mention of his contribution in the training of others. Of teaching he had the highest ideal. He once said: "What higher title could there be than that of a great teacher?" That he himself was one of the world's great teachers will be realized when his influence in the development of medical education in this country is adequately analyzed. To the general problems of education he gave deep thought and great originality. His own teaching was characterized by two broad principles, which were followed in his laboratory; first, that each student might approach his work in the spirit of a discoverer. Second, that since in each class there may be those who are destined to become the intellectual leaders of the next generation, liberty in education is essential in order that the strong personality might develop. In regard to the meaning of liberty in education, I shall venture to be specific in two points: He held that in the planning of courses in the laboratory, the directions for work should not be so minute and specific as to eliminate a student's initiative; and that his time should not be so completely filled with prescribed work that he could not follow his own bent in some line.

Dr. Mall's methods of training others were unique—so bound up with his own rare personality that none could copy, and few describe them. He had a gift, perhaps a genius for stimulating thought. Rarely indeed by question, the quiz he never used; it was more in the nature of an occasional suggestion, the acuteness of which impressed one more and more profoundly as one pondered over it. Perhaps his most fundamental quality was his rare generosity. I recall distinctly an instance in which a student had worked carefully and accurately with him without, however, understanding the meaning or the value of his observations. The student became discouraged and had decided to give up the work when Dr. Mall asked for his notes, and later published a very interesting paper under the student's name. This incident is the more interesting in connection with one of Dr. Mall's letters, written in the early days of the medical school when he was homesick for the laboratory of Leipzig. He told therein that before leaving Leipzig he had given some incomplete studies to Ludwig, evidently expecting him to use them in his own work, but that Ludwig had added experiments and published all under Dr. Mall's name. He then concluded, "Can you blame any one for wanting to return to one who would do things like that?" Ludwig, he wrote, was entirely without selfishness, and that when he tried to thank him for all he had done, he replied, "Pass it on." This indeed became the great watchword of Dr. Mall's life. Most freely did he give his ideas and his energies to his students. You will find no joint research with his students, for all that he gave them he meant to be theirs. He demanded in return the development of high standards of

work. In fact, perhaps the most lasting effect which he made upon the minds of his followers was the value of scientific standards and the meaning of ideals in research. He never gave first-hand praise; the only encouragement which a student received was a genuine interest in his work shown in such a way that the student came to find enjoyment where Dr. Mall found his—in the work itself. Many of his informal talks in the laboratory were on general topics or on principles rather than the specific development of research, and so general, so whimsical were these discussions that their meaning was lost entirely upon more than one student.

In directing departments there are certain leaders who train the students only in their own problems, giving little scope for independent work. Dr. Mall on the contrary was keen to give opportunities to those who could develop an independent line of research. Thus, for example, in his laboratory he developed the method of tissue-culture. Again, though his own work did not lead him into the newer fields of cytology, he saw to it that this work was represented. An even more striking example is that he was the first to see that the methods of anthropology might be applied with great value to the study of embryology; hence he brought into the department of embryology professional anthropologists thereby widening the scope of the science of embryology.

Closely bound up with his own scientific achievements is the part he played in the development of scientific publications in this country. According to his own account when he started out he hoped that the excellent *Journal of Morphology* would care for all the more complete publications of the laboratory, but it became hampered financially and finally suspended publication in 1903. During a term of years, those in the laboratory well remember that he constantly discussed the feasibility of establishing a new journal. At a meeting of the Anatomists held in Baltimore in 1900, a committee was formed to launch the *American Journal of Anatomy* and its first number appeared the following November. In 1906 followed the *Anatomical Record*, both published first in Baltimore. In 1908, when the *Journal of Morphology* was revived by the Wistar Institute of Anatomy, it was with Dr. Mall's work on monsters as its first number. More striking still as an example of Dr. Mall's ideas of developing scientific publications in this country, are the new Contributions to Embryology, published by the Carnegie Institution of Washington. His originality, far-seeing vision and courage for undertaking new enterprises could not be better illustrated than in connection with these journals.

In his introduction to the article on His, Dr. Mall wrote these words:

> The ancient science of anatomy has been perpetuated during many centuries by great men who have dedicated their lives to it. The list is a long one, for the development of science has been slow and progressive from the earliest ages up to the present time; we find in it, on the one hand, some of the names of the greatest who ever lived—Aristotle, Vesalius—on the other, the names of those who rank as leaders of a generation, Bichat, His.

With Bichat and His belongs the name of Mall. His name will be associated with the strongly physiological bent of modern anatomy, with the laying of a broad foundation of organogenesis in embryology, and with the vision of a broadening of the scope of embryology so as to bring it into relation with the problems of clinical medicine and social welfare. In America, his place is unique; it goes without saying that he was our greatest anatomist. More than any other man in American medicine, he had led his generation into the way of research.

FLORENCE R. SABIN

SCIENTIFIC EVENTS

THE BRITISH COMMITTEE FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

Some points in the report of the British Privy Council committee for scientific and industrial research are summarized in the *Electrical World* as follows:

Funds Available.—The Imperial Trust for the Encouragement of Scientific and Industrial Research holds £1,000,000 that Parliament has voted for research purposes. Manufacturers' associations, the London County Council and some governmental departments have also contributed funds for specific purposes.

Personal Grants to Research Workers.—Thirty-six awards in the nature of maintenance grants were made to individuals, of which twenty-four went to students being trained in the methods of research, ten to independent research workers and two to research assistants. Grants will also be made for apparatus and materials.

Industrial Versus Pure Science Research.—During the past year the committee has devoted its chief effort to the organization of industrial research rather than to the prosecution of work in pure science; first, because it felt the paramount importance of arousing the interest of manufacturers and, second, because of the influence of the war. It emphasizes the hope that the absence of references to pure science should not be taken as indicating a lack of appreciation of its importance.

Trade Research Associations.—Many trade associations have lately come into existence, some of which include research among their objects. The committee has helped in their organization and has assisted and cooperated in their research activities.

Research in the Universities.—Hearty cooperation of the principal universities, technical schools and trade schools in England has been secured, and their resources have been coordinated for the important problems on hand. A closer connection is being established between these institutions and the industries which rely upon results of research in the manufacture of their products.

Technical Societies.—The committee is cooperating with the electrical, mechanical and mining engineers' institutions and other professional societies, in some cases subsidizing the researches originated by the institutions and extending their scope.

Information Collected and Published.—In cooperation with technical societies and institutions of learning the committee has collected and published available information and is continuing this useful work, which will greatly simplify that of future investigators. It is also preparing memoranda on various fields for research, with an analysis of the problems involved and the proposed program for research.

Assistance to Individual Manufacturers.—An arrangement has been made with the Royal Society by which it will assist the committee in selecting the institution or research workers best fitted for a particular investigation. If the investigation progresses satisfactorily, the manufacturer is invited to contribute part or all of the expense in exchange for the exclusive use of the results over a given period. Another proposed way is to attach an investigator to the works laboratory and share expense with the manufacturer.

GOVERNMENT CONTROL OF THE PLATINUM INDUSTRY

The Council of National Defense has issued the following statement:

Through Ordinance Requisition No. 510 from the Secretary of War, the government has taken over control of the production, refining, distribution and use of crude and refined platinum for the period of the war. The control will be exercised through the chemical division of the War Industries Board. The chemical division sent out to the industry requests for inventories of the existing stock of crude and refined platinum and platinum-iridium alloys as of March 1, 1918.

The letter stated that it was not the intention of the government to take over and handle directly the present stock of platinum but to permit its shipment by the producers or dealers subject to certain conditions. Upon the fixing by the Secretary of War of a reasonable price for crude, refined and alloyed platinum,

notice will be given and blanks issued governing delivery and distribution.

The letter sent out by the chemical division includes the following directions to producers:

1. That producers, refiners and dealers in platinum continue to dispose of their product for government purposes, and for that only, as directed by the chemical division.

2. That producers, refiners and dealers in platinum who are also consumers use platinum for government purposes, and for that only, as directed by the chemical division.

3. That all obligations arising out of transactions in the production or delivery of crude, alloyed or refined platinum released as above, including all claims for shortage, poor quality, damage or loss in transit, be borne by the producer or seller, as the case may be, in accordance with existing trade practises.

Distribution may be made by consent of this board through agencies under existing arrangements, provided that there results no increase over the existing price to the user.

The undersigned, on separate application in each case, will consider permitting the delivery of a limited amount of platinum for essential commercial purposes not for government account.

Proper blanks upon which application for re lease of shipment should be made will be furnished on application.

The following list indicates, in general, the order of preference which will be followed in releasing platinum for shipment: First, military needs of the United States government; second, military needs of allied governments; third, essential commercial purposes.

PHOTOGRAPHERS FOR THE SIGNAL CORPS

ONE thousand men trained in photographic work are needed by the Signal Corps immediately for instruction at the new school for aerial photography just opened at Rochester, N. Y., preparatory to going overseas.

This ground force for America's aerial photography requires three types of men:

1. Laboratory and dark room experts, especially fast news photographers, familiar with developing, printing, enlarging, retouching, finishing and panchromatic photography, who can take a plate from the airmen and hand it over ten minutes later a finished enlargement to the staff officers. These men will work in motor lorries as close to the front and to the staff as possible.

2. Men able to keep the whole delicate equipment in good condition, such as camera and optical construction and repairmen, lens experts, cabinetmakers, instrument makers, etc.

3. Men to fit the finished prints into their proper places in the photographic reproduction of the German front, to work out the information disclosed, and to keep the whole map a living hour-to-hour story of what the Germans are doing. This includes men familiar with map compilation, map-reading and interpretation, topographical science and drafting, and requires keen analytical powers.

The primary training at Rochester will cover four weeks, and will be standardized along the highly specialized developments brought out in the war. At its close the successful graduates will be sent on for a month of advanced training, after which they will be organized into units and sent overseas.

The best men, however, will be given still further training for commission as photographic intelligence officers first at one of the schools and then in actual flights at the flying fields.

Many men not physically fit for line service are eligible for this so-called limited military service, as defective vision corrected by glasses and other minor physical disabilities are waived. The proportion of officers and non-commissioned officers to privates will be higher here than usual, so that the opportunity for advancement is good.

Men not registered for the draft and who possess the necessary qualifications should write to the Air Division, Personnel Department, 136 K Street, NE., Washington, D. C., for information as to enlistment, accompanying their letter with evidence of their qualifications.

Men registered for the draft in the states of New York, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Missouri Massachusetts, New Jersey, Rhode Island and Maryland, who desire to be voluntarily indicted for this service, should apply to their local board and submit evidence of their qualifications. At present

these are the only states to which this call applies.

Owing to the shortness of time it is requested that only men fully qualified apply for this service.

SCIENTIFIC NOTES AND NEWS

Professor William F. Durand, of Stanford University has been made chairman of the National Advisory Committee for Aeronautics.

Four of the college deans or former deans of Ohio University are now majors in the National Army: Dr. Edward Orton, Jr., of the College of Engineering; Dr. William McPherson, of the Graduate School; Dr. Eugene F. McCampbell, of the College of Medicine, and Dr. David S. White, of the College of Veterinary Medicine. Dr. Henry R. Spencer, appointed dean of the Graduate School in Dr. McPherson's absence, is now in Y. M. C. A. service abroad.

Dr. William Libbey, professor of physical geography at Princeton University, has been commissioned major in the Ordnance Department, and is now awaiting orders. He has long held a commission in the New Jersey National Guard.

Dr. George S. Meylan, associate professor of physical education at Columbia University, has been granted a further leave of absence to continue his work with the Y. M. C. A. in France.

Dr. W. B. Bentley, head of the Department of Chemistry of Ohio University, has been commissioned as captain by the War Department, and is stationed at Watertown, Massachusetts, in the Department of inorganic chemistry, of the Watertown Arsenal.

Dr. Bird T. Baldwin, who last year left Swarthmore College to accept the directorship of a newly established child-welfare station of the Iowa State University has enlisted in the sanitary corps of the army. He has the rank of major and will be engaged in the work of testing recruits by psychological methods.

Dr. Henry H. Goddard for ten years head of the research department of the Vineland training school, has been appointed head of the Bureau of Juvenile Research of the State of Ohio. Dr. Goddard will go to Ohio in May, returning to the Training School for the Summer School for Teachers to take charge of the laboratory work.

Watson Bain, professor of applied chemistry at the University of Toronto, has been granted leave of absence for the duration of the war. He is going to Washington, D. C., where he will be on the staff of the Canadian mission.

Colonel Herbert S. Birkett, C.M.G., dean of the medical faculty of McGill University, Montreal, and who has been overseas in command of their base hospital, has returned home on account of ill health. Colonel John M. Elder has taken over the command of the hospital.

Dr. John E. Bucher, professor of chemistry in Brown University, has been granted leave of absence for the second semester of the academic year, in order to devote himself to experimentation in chemical processes in the industry. He will continue to direct the work of certain advanced students in the university laboratory, but will be relieved of all teaching during the remainder of the year. Dr. Robert F. Chambers, a Brown graduate, will be acting head of the department during the second semester.

Dean R. H. Forbes, of the University of Arizona College of Agriculture, and for eighteen years director of the Arizona Agricultural Experiment Station, has been granted a year's leave of absence for agricultural service in Egypt and is at present en route for Cairo. Dean Forbes is a specialist in semi-arid subtropical agriculture of the kind common to both Arizona and Egypt.

Dr. A. I. Ringer has been appointed special consultant in diseases of metabolism at the German Hospital, New York City.

Stephen S. Visher, Ph.D. (Chicago), has been appointed a land classifier in the United States Geological Survey.

Professor H. H. Love and Instructor William T. Craig, of the department of plant breeding, Cornell University, are cooperating

with the Federal Department of Agriculture in breeding improved cereals.

DR. MOURIER, who represents the Gard in the French Chamber of Deputies, has succeeded M. Godard as under secretary for health in the Ministry of War.

THE British Minister of Pensions has appointed Sir John Collie to be director of medical services for the Ministry of Pensions.

SIR NAPIER SHAW, director of the British Meteorological Office, has been elected a foreign honorary member of the American Academy of Arts and Sciences, Boston.

THE British polar medal has been given to Lieutenant Sir Ernest Shackleton, Lieutenant Frank Wild and forty-two other members of the Imperial Transantarctic Expedition of 1914–16.

AT the anniversary meeting of the Royal Astronomical Society held on February 8 the officers and council elected, as recorded in *Nature,* are as follows: *President,* Major P. A. MacMahon; *Vice-presidents,* Professor A. S. Eddington, Dr. J. W. L. Glaisher, Professor R. A. Sampson and Professor H. H. Turner; *Treasurer,* Mr. E. B. Knobel; *Secretaries,* Dr. A. C. D. Crommelin and Professor A. Fowler; *Foreign Secretary,* Dr. A. Schuster; *Council,* Mr. A. E. Conrady, the Rev. A. L. Cortie, S.J., Dr. J. L. E. Dreyer, Sir F. W. Dyson, Colonel E. H. Hills, Mr. J. H. Jeans, Mr. H. S. Jones, Mr. E. W. Maunder, Dr. W. H. Maw, Professor H. F. Newall, Professor J. W. Nicholson and the Rev. T. E. R. Phillips.

SIR J. C. BOSE delivered an address at the recent opening ceremony of the Bose Research Institute at Calcutta, of which he is the founder.

PROFESSOR WILLIAM M. DAVIS, Sturgis-Hooper professor emeritus of geology, has prepared a "Handbook of Northern France," which has the approval of the geography committee of the National Research Council, and a considerable number of copies will be distributed free at cantonments, which thirty contributors to a fund of nearly $3,000 may designate. The Harvard University Press will print the book, which will also be placed on sale.

ELMER V. MCCOLLUM, Ph.D., professor of chemistry in the school of hygiene and public health, the Johns Hopkins University, will give the Cutter Lectures on Preventive Medicine and Hygiene, at the Harvard Medical School on March 19, 20 and 21. The subjects are: "The essentials of an adequate diet," "The special dietary properties of our natural foodstuffs" and "The dietary habits of man and their relation to disease."

THE course of lectures on "Wild Life" at Cornell University for the month include "The economic value of birds" and "The cat and rat problem," by E. H. Forbush, state ornithologist of Massachusetts; four lectures on pheasants, breeding, care and rationing of the young, combating of vermin and disease, and miscellaneous problems, by E. A. Quarles, of the American Game Protective Association, and H. T. Rogers, superintendent of the State Game Farm; "The breeding of wild turkeys" and "The breeding of diving ducks," by H. K. Job, of the National Association of Audubon Societies.

A COURSE of public lectures on "Animal life and human progress" is being given at King's College, London. The program includes Professor A. Dendy on "Man's account with the lower animals"; Professor G. C. Bourne on "Some educational and moral aspects of zoology"; C. Tate Regan on "Museums and research"; Professor J. Arthur Thomson on "Man and the web of life"; Professor F. Wood Jones on "The origin of man"; Dr. R. T. Leiper on "Some inhabitants of man and their migrations"; Professor R. T. Punnett on "The future of the science of breeding"; Professor W. A. Herdman on "Our food from the sea"; and Professor Robert Newstead on "Tsetse-flies and colonization." It is intended to publish the lectures in book form.

THE Brooklyn Teachers' Association has appropriated $1,000 toward the fund to erect a memorial to the late Franklin W. Hooper, the founder of the Brooklyn Museum.

Dr. Alfred Lacroix, secrétaire perpétuel of the Académie des Sciences, Paris, and professor and curator of the department of mineralogy of the Muséum d'Histoire Naturelle, of Paris, has in preparation a life of the great mineralogist *Dolomieu* (1750–1801), and is interested in any information leading to the location of manuscripts, letters or signatures of that great scientist. Any letters or signatures of Abbé René Just Haüy are especially desired, and these, or any information relating to them, can be addressed to George F. Kunz, Abbé Haüy Celebration Committee, 405 Fifth Avenue, New York City.

Steps have been taken to raise a memorial to the late Dr. Elizabeth Garrett Anderson from the women of England. It will be devoted to the endowment of beds in the New Hospital for Women, Euston Road, which she founded in 1866. A sum of over £9,000 has already been received, and a number of women's colleges and schools have undertaken to raise £7,000.

Dr. Charles Parker Lyman, who was fifteen years dean of the Harvard School of Veterinary Medicine, died in Los Angeles, on February 1, aged seventy years.

Lieutenant Colonel John McCrea, of the Canadian Army Medical Corps and the department of pathology of McGill University, has died in France.

The late Dr. Ludwig Mond undertook to pay £62,000 as an endowment fund for the David Faraday Research Laboratory of the Royal Institution before 1926. His trustees have now anticipated the obligation, and have transferred £66,500 in 5 per cent. war stock to the trustees of the Laboratory.

Undergraduates between the ages of eighteen and twenty-one in technical colleges may enroll as second class seaman in the Naval Reserve force for future service, according to the announcement of the Bureau of Navigation of the Navy Department. The students will not be called upon for active duty until they have been graduated, except in case of great emergency, which is not now anticipated by naval authorities. No promise is held out that the recruits will later be commissioned, but upon graduation they will take examinations, and the ratings they make will determine whether their qualifications merit promotion. Navy recruiting officers have been instructed to communicate with technical colleges and universities with a view to enrolling students who are eligible.

The United States Public Health Service of the Treasury Department has practically completed plans for preventing malaria among soldiers at camps and cantonments during the coming spring and summer. In a zone from one to two miles wide around twenty or more camps in the south every known effective method of eradicating the disease will be employed under the supervision of experts. In the camps themselves the Army authorities will control the disease. At each camp where there is danger of malaria an expert, probably a sanitary engineer, will be in charge of the malaria operations.

Sir A. Mond said, in the House of Commons on February 18, as quoted in *Nature*, that the Imperial Institute was partly occupied for the sugar rationing purposes of the Ministry. As to the new Science Museum, it was in course of construction, and incomplete. It had been represented that the work of construction ought to be continued during the war, but he was not in a position to complete the construction of museums in existing circumstances. Considerable expense had been incurred in making the finished part of the building suitable for the work now to be done there. Museums now wholly or partly occupied by government departments were the National Gallery, the Tate Gallery, the Wallace Gallery, the Victoria and Albert Museum and the British Museum, of which a small part had been taken over.

UNIVERSITY AND EDUCATIONAL NEWS

Richmond College has received a gift of $60,000 from Mr. and Mrs. Clarence Millhizer, of Richmond, Va. This sum is to be used in the erection of a gymnasium which will be a

memorial to their son, whose death occurred on February 24.

BY the will of Mrs. Charlotte M. Fiske, of Boston, public bequests to the amount of $130,000 are made. Tuskegee Normal School, Roanoke College and Bates College receive $5,000 each and Wellesley College receives $10,000 and the residue of the estate.

SENATOR W. C. DENNIS, president of the *Halifax Daily Herald,* has presented $60,000 to Dalhousie University in memory of his son, Captain Eric Dennis, killed at Vimy Ridge. The gift provides that the university shall found a chair of government and political science.

DR. EDWIN BISSELL HOLT, assistant professor of psychology at Harvard University has resigned, his resignation to take place on September 1, 1918.

AT the University of Chicago Dr. Harvey B. Lemon, instructor in the department of physics, has been promoted to an assistant professorship; and Dr. A. L. Tatum, professor of pharmacology in the University of South Dakota, has been made an assistant professor in pharmacology and physiology.

T. J. MURRY, formerly associate bacteriologist of the Virginia Agricultural Experiment Station and associate professor of bacteriology at the Virginia Polytechnic Institute, has been appointed associate professor of bacteriology at the State College of Washington and bacteriologist of the Washington State Experiment Station.

DISCUSSION AND CORRESPONDENCE

THE NOMENCLATURE OF THERMOMETRIC SCALES

TO THE EDITOR OF SCIENCE: Present usage in nomenclature of thermometric scales is a cause of indefiniteness and confusion of ideas, and some revision seems called for. Accordingly, I hope the statement of the case which follows[1] will elicit helpful suggestions and tend toward useful results.

The consensus of scientific opinion and practise is all but universally in favor of the familiar Centigrade scale of temperatures by which the temperature of melting ice and of condensing steam, both from water and under a pressure of one standard atmosphere, are designated 0° and 100° respectively. By general consent the value of other temperatures than the two points thus fixed by definition are defined by the normal constant volume hydrogen thermometer of the International Bureau of Weights and Measures as realized by certain mercury in glass thermometers. In recent years the scale of temperatures defined by the varying resistance of pure platinum is also accorded the status of a thermometric standard when its thermal coefficient as defined by the Callendar equation is evaluated by observations at the melting and boiling points of pure water, and at the boiling point of sulphur under standard conditions defined to be 444.5° or 444.6° C.

All other thermometric scales that depend on the physical properties of substances may, by definition, be made to coincide at the ice point and the boiling point with the normal scale as above defined, but they will diverge more or less from it and from each other at all other points.

To obviate the difficulty which arises because thermometers of different types and substances inherently disagree except at the fixed points, Lord Kelvin proposed many years ago that temperatures be defined by reference to certain thermodynamic laws. This course furnishes a scale independent of the nature or properties of any particular substance. The resulting scale has been variously named the absolute, the thermodynamic, and more recently in honor of its author, the Kelvin scale. The temperature of melting ice by this scale on the centigrade basis is not as yet accurately known, but it is very nearly 273.13°, and that of the boiling point 373.13°.

Occasions arise with increasing frequency in which meteorologists, physicists, and others in dealing with problems of temperature are required to use an absolute scale or an approximation thereto, and to publish temperature data in those units. It is not convenient, and in many cases not necessary, to adhere

[1] See also Monthly Weather Review, Nov., 1917.

strictly to the true thermodynamic scale. In fact, the general requirements of science are very often largely met by the use of an *approximate* absolute scale which, for the centigrade system, is defined by the equation

$$T = 273. + t° \text{ Cent.}$$

The observed quantity, $t°$, may be referred to the normal hydrogen centigrade scale or be determined by any acceptable thermometric method. This approximate scale is often called the "absolute" or the Kelvin scale, perhaps for the sake of brevity or convenience. Of course, no one can disregard the technical differences between the real and false or approximate, absolute scale.

Such a scale differs from the true Kelvin scale, first, because 273° is not the exact value of the ice point on the Kelvin scale; second, because each observed value of $t°$ other than 0° or 100° requires a particular correction to convert it to the corresponding value on the Kelvin scale. These corrections will differ according to the kind of thermometer used in obtaining the value $t°$ and while they are small for temperatures between 0° and 100° they are large at extreme temperatures and are important in all questions involving thermometric precision.

The *approximate* absolute scale is sufficiently exact for nearly all purposes, it is most convenient in computations and in the publication of results; further, its numerical quantities are strictly homogeneous, and should any necessity arise data published in its units may be readily reduced to the absolute Kelvin scale by simply applying the appropriate correction for the zero point of the scale—about 0.13° C.—and the other appropriate correction to reduce the observed temperature, $t°$, to the true thermodynamic temperature. It is thus clear that much confusion and uncertainty of terminology and meaning would be obviated and Kelvin's suggestion properly appreciated if scientists would agree to *give the approximate absolute scale a particular name of its own* and reserve the name "absolute" for the scale that is truly absolute, viz., Kelvin's absolute thermodynamic scale.

In accordance with the foregoing ideas, the thermometric scale and nomenclature in the centigrade system may be set forth in the following manner:

THERMOMETRIC NOMENCLATURE

AS IT IS

	Fiducial Points	
Centigrade scale	Freezing	Boiling
Normal hydrogen constant-pressure thermometer	0°	100°
Thermodynamic scale Absolute scale Kelvin scale Approximate or "near-absolute" scale defined by the equation— $T = 273 + t°$ Cent.	All frequently loosely designated Absolute Scale in scientific literature.	

AS IT SHOULD BE

Centigrade scale	0°	100°
Thermodynamic scale Absolute scale Kelvin scale	273.13° Strictly synonymous and strictly one ideal scale.	373.13°
"Approximate-absolute (?)"	273°	373°

Let us prevent confusion and uncertainty, make the meaning of scientific writings clear and distinct, by giving an appropriate name to the scale

$$T = 273 + t° \text{ Cent.}$$

Such a name will have the significance of—

Quasi-absolute, symbol Q or A_q.
Approximate absolute, symbol A_a, or *aa*.
Pseudo-absolute, symbol P.

It should be a short word if possible and suggest a good symbol for its abbreviation. The above list of names is tentative and suggestions from others are requested.

C. F. Marvin

Weather Bureau,
Office of the Chief,
Washington, D. C.

THE DOMESTICATION OF THE LLAMA

To the Editor of Science: For many years one of the favorite arguments of those who wish to prove an immense antiquity for the peoples of the Andean area has been that thousands of years must have gone by before the llama and its kindred, the alpaca, the vicuna, the huanacu, could have been brought

to their present condition of domestication. In the opinion of the present writer, who is now in Peru and who has lately been in Bolivia as well, this argument is of slight, if any, value. From close study of the matter it becomes clear that the llama is only partially domesticated. There are several criteria of domestication: If an animal depends upon a man for its food, if it breeds while in captivity, if it needs to be artificially sheltered from the stress of weather, if it is obedient to the wishes of its owner, it may be said to be domesticated. It is quite certain that by far the greater part of the llama species to-day feed themselves, refuse to breed in captivity (or, at any rate, generally breed when as far as possible from man), and do without shelter. It is true that the llama is more or less obedient to its owner, but it is a docile animal by nature, and, so long as it is not overloaded, it is a ready worker in its own way. Since this is so, it is quite clear that the llama is only partially domesticated, or rather, that it has been partially subjected to the uses of man, and it is certain that its status does not imply any long period of human influence.

PHILIP AINSWORTH MEANS

LIMA, PERU,
November 29, 1917

THE ORIGIN OF THE CUSTOM OF TEA DRINKING IN CHINA

TO THE EDITOR OF SCIENCE: I have been much interested in a statement which occurs in the late Professor King's book "Farmers of Forty Centuries" relative to the origin of the custom of tea drinking in the Orient. Professor King states (p. 77):

> In a sampan managed by a woman and her daughter, who took us ashore, the middle section of the boat was furnished in the manner of a tiny sitting-room, and on the sideboard sat the complete embodiment of our fireless cookers, keeping boiled water hot for making tea. This device and the custom are here centuries old and throughout these countries boiled water, as tea, is the universal drink, adopted no doubt as a preventive measure against typhoid fever and allied diseases.

And (p. 323):

> The cultivation of tea in China and Japan is another of the great industries of these nations, taking rank with that of sericulture, if not above it, in the important part it plays in the welfare of the people. There is little reason to doubt that the industry has its foundation in the need of something to render boiled water palatable for drinking purposes. The drinking of boiled water has been universally adopted in these countries as an individually available, thoroughly efficient and safe guard against that class of deadly disease germs which it has been almost impossible to exclude from the drinking water of any densely peopled country.

These statements would indicate the following sequence of events: (1) the pollution of the drinking water, (2) disease arising from this pollution, (3) boiling of the drinking water to prevent disease, (4) addition of tea leaves to mask the insipid taste of the boiled water. While I have no doubt but that the first two items occurred in the order given, I have very grave doubts as to the sequence of the third and fourth items. It is extremely improbable that it was recognized centuries ago that typhoid fever, etc., were disseminated by pollution of the water supply, especially inasmuch as there was no knowledge of microorganisms or of the rôle which they play in disease until the work of Pasteur (1857–1863). Undoubtedly disease with the Chinese, as with every other people, was early regarded as the act of demons or a visitation of the gods.

To my mind, cause and effect were somewhat as follows: (1) The drinking water was undoubtedly polluted and typhoid, cholera, dysentery, etc., were endemic. (2) Certain families or clans found that a pleasing beverage could be made by steeping the leaves of the tea plant in hot water with the result that they drank very little if any of the polluted waters without previously boiling it. (3) Their neighbors or neighboring communities observed that these families or clans who drank tea had relatively little disease as compared with the non-tea drinkers and as a result the custom of tea drinking spread

throughout the land not because of the belief that boiled water prevented disease and tea leaves modified the insipid taste of the boiled water, but because the infusion of the tea leaves *per se* was looked upon as a medicine specific for the prevention of the prevalent diseases.

Ross Aiken Gortner
University of Minnesota

SCIENTIFIC BOOKS

Applied Psychology. By H. L. Hollingworth and A. T. Poffenberger. D. Appleton and Co., New York, 1917. Pp. xiii + 337.

This book will properly attract many readers who wish to know the significance of the practical movement in psychology. As the first text-book in applied psychology it gives a well-balanced presentation of the aims, methods and scope of this new "type of interest and pursuit." Nowhere else have the results and methods of approach for practical problems been so completely assembled and so well guarded from misuse. Although it does not reach the dignity of a treatise on applied psychology, this admirable book by two members of the department of psychology at Columbia University will be appreciated both by general readers and by those psychologists who wish to vitalize their introductory courses by associating them with student interests. Only a few colleges as yet have offered a course which attempts to cover the broad field of applied psychology, but within a year a professorship in applied psychology has been established, the *Journal of Applied Psychology* started, and a Division of Applied Psychology under that title organized in an institute of technology. Whether a unit of instruction entitled applied psychology touches too varied interests and affords too meager content will doubtless continue for some time to be a question for each college to decide. It is certainly too early to expect a text to take the place of a teacher.

Besides bringing the results of many scattered researches together, the authors have helped to organize this branch of psychology by carefully distinguishing and illustrating three main forms of application to practical problems. These three forms include psychological analysis of a situation, carrying over of principles worked out in allied researches, and the adaptation and improvement of technique. With this scientific procedure in the foreground, they have avoided the unpleasant effect on the student of either a very limited technical monograph or of the magazine literature of the prophetic promoter. The first portion of the book summarizes in compact and usable form the psychological work which helps to understand general human efficiency and how to increase it. It includes the influences of heredity, sex and maturity, environmental factors like illumination and ventilation, the principles derived from the studies of the learning process, the effects of work and rest, stimulants, etc. The second half of the book sets forth the psychological procedure in those fields of occupational activity in which the applications have been most explicit. These include employment management, the industrial workshop, advertising and salesmanship, law, social work, medicine and education.

The task of guarding the foundations of the new division of their science has not been assumed lightly by the authors. Instead of the usual illustrations from individual cases, which may or may not be exceptions, we find the constant citation of experiments bearing upon a problem with a careful discussion of the sources of error and the dangers of generalization from the particular investigation. Instead of mere psychologizing about work methods we now have much emphasis on the technique under which the conclusions were reached. The teacher of the consulting psychologist must evidently train him in technical methods of research and the interpretation of results. The authors look forward to that day when the engineering type of psychotechnical expert will meet with other specialists to cooperatively attack their joint problems, instead of the make-shift procedure under which the specialist in business, medicine, education, etc., attempts to dabble in psychology or the psychologist to dabble in other specialties.

To those who studied their psychology with the introspectionist school it must be strange to find brought together under a psychological heading, the work of the physiologist on drugs and fatigue, of the engineer on motion-study, of the biologist on heredity, of the psychiatrist on mental abnormality, of the clinician on mental development, and of the educator on learning, in addition to the research of the psychologists. It marks the change in psychology to the more objective study of behavior. Applied psychology rejoices that it affords a clearing house for any knowledge which bears directly upon the understanding and control of human action.

The authors cite telling examples in which scientific studies of the human factor have produced better results than the hit-or-miss methods of practical sense in dealing with business, industrial, and professional problems. In many other cases than industrial accidents it will doubtless be found that the most important cause to be controlled is not in the field of the applied physicist but in the field of human engineering. In leaving the book, if the reader still feels that we are yet only on the threshold of a new pursuit, he will at least have found abundant evidence scientifically formulated to convince him that we are on the threshold and not merely viewing the house at a distance.

J. B. MINER
CARNEGIE INSTITUTE OF TECHNOLOGY

SPECIAL ARTICLES

NOTE ON THREE DEVICES FOR USE IN ELECTROMETRY

DURING recent work with an electrometer the author has employed three devices which are obvious enough and can hardly be novel, but which seem worth putting more definitely on record as tested devices.

(1) A simple means of increasing the deflections of an electrometer is often wanted under circumstances where the use of a sufficiently long distance from mirror to scale is inconvenient. This may be accomplished by interposing a concave lens between mirror and scale, thus magnifying the deflection. A lens of rather long focus placed, if anytihng nearer the mirror (fig. 1) is preferable, as the effects of chromatic aberration are thereby diminished and the proportionality of the deflections is also better preserved. The image will be much brighter if a *cylindrical* lens is used; such a lens can be secured quickly and at small expense as a special order from Bausch & Lomb.

By this means a Dolezalek electrometer with platinum fiber was raised from 3,000 to 18,000 mm. per volt at a scale distance of 4 m. Owing to diffraction, the spot was about 1 mm. wide, but its position could be read to 0.2 mm., and the proportionality between deflection and potential was very good.

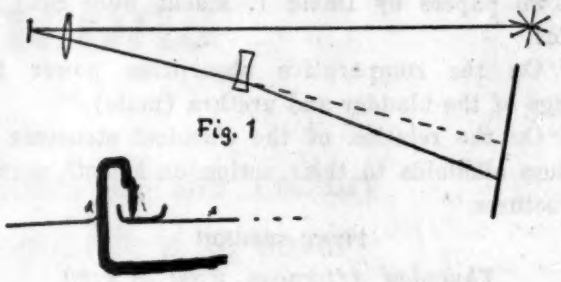

Fig. 2.

(2) Sometimes one wants a simple means of connecting two wires together which will permit of easier disconnection than a soldered joint and yet will not introduce the additional capacity and possible leakage of a key. For this purpose one may solder a little silver cup to one wire and then attach the other wire to a piece of heavy wire tipped with a silver point and bent so that the point rests upon the floor of the cup (fig. 2). Silver oxide being a fairly good conductor, the slight pressure thus obtained is quite sufficient to make good contact.

(3) To obtain time signals at rather long intervals a torsion pendulum is more useful than a gravity pendulum because of the ease with which the period may be varied over a wide range. If the inertia system consists of a light cross-rod carrying two heavy sliding weights, then the period is approximately proportional to the distance of the weights from the center, so that a range of 1 to 10 in the period is easily obtained. The system can be

rendered stable by a rigid upright in the center; and a wire on one end of the cross-rod is easily arranged to close a mercury contact and actuate a sounder.

E. H. Kennard
University of Minnesota

THE AMERICAN SOCIETY OF PHARMACOLOGY AND EXPERIMENTAL MEDICINE

The ninth annual meeting of the American Society of Pharmacology and Experimental Therapeutics was held in Minneapolis on Thursday and Friday, December 27 and 28, 1917, and in Rochester, Minnesota, on Saturday, December 29. The following program was presented:

Two papers by David I. Macht were read by title:

"On the comparative absorption power for drugs of the bladder and urethra (male)."

"On the relation of the chemical structure of opium alkaloids to their action on smooth muscle structures."

First Session

Thursday Afternoon, 2:00 to 4:30

Experimental observations on anaphylaxis in the dog: Mort D. P., and D. E. Jackson.

Effect of adrenalin on vaso-motor and on heart action studied separately by means of elimination of blood pressure through compensation: C. McPeek, R. J. Seymour and Clyde Brooks, University of Ohio.

The action of drugs on different parts of the intestine: W. C. Alvarez, Hooper Institute, San Francisco.

The location of the adrenalin vasodilator mechanisms: Frank A. Hartmann, University of Toronto.

The growth of chickens under laboratory conditions: Lafayette B. Mendel and Thomas B. Osborne, Yale University and Connecticut Experiment Station.

The Distribution and Function of Certain Nerves: D. E. Jackson and Mort P. Pelz, Washington University.

Studies with American grown digitalis and with digitalis lutea: S. M. White and R. E. Morris, University of Minnesota.

The effect of alcohol on the vaso-motor and respiratory mechanisms: E. G. Hyatt and Viggo Jensen, Illinois University Medical College.

The influence of Yohimbine on reproductivity: Florence L. Rumry, Illinois University Medical College.

The action of lactic acid on the respiratory center: Seymour J. Cohen, Illinois University Medical College.

The stimulation of the vago-gastric medullary center by drugs: Fred. T. Rogers, University of Chicago.

Second Session

Friday Morning, 9:00 to 12:00 M.

Effects of iodine on the eggs of sea urchins: E. P. Lyon, University of Minnesota.

Antagonistic action of drugs on the respiratory center: C. Voegtlin and C. J. Wiggers, Hygienic Laboratory, Washington, D. C.

Stimulation of the respiration by sodium cyanide: A. S. Loevenhart and Messrs. Lorenz, Martin and Malone, University of Wisconsin.

The reaction of the respiratory mechanism to chlorine gas: W. H. Schultz, University of West Virginia.

The influence of chlorine upon the heart: W. H. Schultz, University of West Virginia.

A study of acute bichloride intoxication in the dog: Wm. DeB. MacNider, University of North Carolina.

Cross tolerance: renal response to caffein and theobromin in rabbits long tolerant to caffein: Harold B. Myers, University of Oregon.

Straub's biologic test for opium alkaloids: Florence L. Rumry and Viggo Jensen, Illinois University Medical College.

The influence of pituitary extracts on the daily output of urine: H. M. Rees, University of Chicago.

Effects of external temperature and certain drugs on thyroid activity: A. C. Mills, University of Kansas.

Does atropin alter the effects of digitalis upon the tonus of heart muscle: A. D. Hirschfelder, University of Minnesota.

Effects of amino acids and their salts upon the contraction of intestinal strips: A. D. Hirschfelder and W. Cantwell, University of Minnesota.

Acridity of some plants due to a mechanical action: E. D. Brown and D. D. Anderson, University of Minnesota.

The mode of action or anesthetics in producing anesthesia: W. E. Burge, University of Illinois.